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09/761,240

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Josef-Georg Bauer

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07/24/2006

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EXAMINER

MONDT, JOHANNES P

ART UNIT

PAPER NUMBER

3663

DATE MAILED: 07/24/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

**Office Action Summary**

Application No.

09/761,240

Applicant(s)

BAUER ET AL.

Examiner

Johannes P. Mondt

Art Unit

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

- 1) ☒ Responsive to communication(s) filed on 12 May 2006.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

- 4) ☒ Claim(s) 5,7 and 8 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 5,7 and 8 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

**Application Papers**

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

**Priority under 35 U.S.C. § 119**

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some \* c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
  2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
  3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

\* See the attached detailed Office action for a list of the certified copies not received.

**Attachment(s)**

- |  |   |
|--|---|
| 1) <input type="checkbox"/> Notice of References Cited (PTO-892)   | 4) <input type="checkbox"/> Interview Summary (PTO-413)<br>Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948)                                   | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152)             |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)<br>Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____  |

## DETAILED ACTION

### *Response to Amendment*

Amendment filed 5/12/06 forms the basis for this office action. In said Amendment applicants cancelled claim 6 and substantially amended claims 5, 7 and 8 through substantial amendment of claim 5. Comments on Remarks submitted with said amendment are included below under "Response to Arguments".

### *Claim Rejections - 35 USC § 103*

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

1. **Claims 5 and 8** are rejected under 35 U.S.C. 103(a) as being unpatentable over Bauer et al (5,668,385) in view of Gerstenmaier et al (DE 39177769 A1) (both made of record and cited previously).

*Bauer et al* teach a power semiconductor element comprising:

an emitter region 6/8 (cf. col. 5, l. 64 – col. 6, l. 3);  
a stop zone 7 (cf. abstract and col. 4, l. 59-61) in front of said emitter region;  
said emitter region and said stop zone having mutually opposite conductivities (p-type emitter, n-type stop zone: see col. 4, l. 56-61); and said stop zone having foreign atoms by virtue of being doped with an n-type conductivity doping substance (col. 4, l. 50-61).

*F. Bauer et al* do not teach the further limitation that said atoms of said doping substance have at least one energy level within the band gap of the semiconductor and at least 200 meV away from both a conduction band and a valence band of the semiconductor.

However, it would have been obvious to include said further limitation in view of *Gerstenmaier et al*, who, in a published patent application on a thyristor (cf. title; hence closely related to the GTO (Gate-Turn-Off) thyristor-relevant art by F. Bauer et al; see F. Bauer, abstract), teach that in n-type recesses 11 (cf. col. 2, l. 4) between p-emitter portions 4 (cf. col. 1, l. 53-57) on the anode (A) side (cf. Figure 1) the dopant should be selected so as to have an ionization energy level within the band gap of the semiconductor and at least 300 meV away, a fortiori at least 200 meV away, from both a conduction band and a valence band of the semiconductor (cf. col. 2, l. 49 – col. 3, l. 17), *for the specifically stated purpose* to reduce the temperature dependence of the threshold current (cf. abstract and col. 2, l. 30 – col. 3, l. 17) through an increase in the slope of the conductivity versus temperature. The strong dependence on temperature of the occupancy level of the conduction band (cf. col. 3, l. 2-6) inherently implies the number of effective doping atoms generated in the stop zone, i.e., the number of atoms having contributed a charge carrier to the conduction band, to change in dependence on whether the power semiconductor element is in a blocking operation (no ohmic heating) or in a conducting operation (ohmic heating), because in the conducting state the temperature is higher relative to the blocking state in view of the ohmic heating associated with any current flow in a resistive medium. In particular,

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Gerstenmaier et al advocate the selection of selenium atoms as said foreign atoms (see their claim 7), thus also specifically teaching the further limitation of claim 8 for the same motivation.

The further limitation “resulting in said stop zone being only partially electrically active in the on-state and fully electrically active in the off-state” is automatically met to the extent patentable, because the stop zone is in front of the emitter and is doped with foreign atoms with at least one energy level within the band gap of the semiconductor at least 200 meV away from both the conduction band and valence band of the semiconductor, and hence said stop zone is *capable* of being only partially electrically active in the on-state and fully electrically active in the off-state. Furthermore, said limitation constitutes functional language, because intended use and other types of functional language must result in a structural difference between the claimed invention and the prior art in order to patentably distinguish the claimed invention from the prior art. If the prior art structure is capable of performing the intended use, then it meets the claim. In re Casey, 152 USPQ 235 (CCPA 1967); In re Otto, 136 USPQ 458, 459 (CCPA 1963).

*Motivation* to include the teaching by Gerstenmaier in this regard in the invention by F. Bauer et al derives from the resulting constancy, hence increased reliability, of the threshold voltage as well as the broadening of the temperature range towards higher temperatures within which the maximal blocking voltage of the thyristors can be secured (cf. col. 1, l.27-37).

*Combination* of the teaching by Gerstenmaier et al with the invention by F. Bauer is easily achieved by selecting the dopant according to the criterion by Gerstenmaier on ionization energy levels in relation to the semiconductor band gap (Gerstenmaier lists a few examples, such as Molybdenum, Germanium, Cesium, Barium, Selenium and Niobium; for additional possibilities see S.M. Sze, "Physics of Semiconductor Devices", page 21, in which a list is provided including the case specifically cited by Gerstenmaier et al when the semiconductor is silicon (cf. col. 3, l. 13)). The practical implementation of the combination only involves selecting the dopant for the recesses between p-emitter regions 8 within stop layer 7 (cf. Figure 1b). Success of the implementation of said combination can therefore be reasonably expected.

2. **Claim 7** is rejected under 35 U.S.C. 103(a) as being unpatentable over F. Bauer et al in view of Gerstenmaier et al as applied to claim 5, and further in view of Tohyama (all as cited in the previous office action).

*As detailed above, claim 5 is unpatentable over F. Bauer et al in view of Gerstenmaier et al.*

*Although F. Bauer et al nor Gerstenmaier et al do not necessarily teach the further limitation that the selection of said foreign atoms is to include sulfur (S), it would have been obvious to include said further limitation because*

(a) sulfur (S) has long been applied as a dopant in silicon for its deep ionization level so as to tailor the current-voltage characteristics of said silicon, as witnessed by Tohyama (cf. col. 6, l. 66 – col. 7, l. 11). In this regard it is noted that the doping in Tohyama and Gerstenmaier et al serve the same purpose in that the resulting

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temperature dependence of the occupancy levels of the conduction band inherently leads to a desired change in the current-voltage characteristic due to ohmic heating. Applicant is reminded that sulfur (S) is known to meet the physical criterion stated by Gerstenmaier et al for the selection of said atoms, as evidenced by the scientific data on donor and acceptor ionization energies of sulfur (S) in silicon (see e.g., S.M. Sze, "Physics of Semiconductor Devices", Figure 13, page 21, previously made of record (5/15/2002)): from said list it is evident that sulfur satisfies the aforementioned physical criterion. It is thus evident from Tohyama that *combination* of the teaching by Tohyama of the inclusion of sulfur as the deep ionization energy dopant only requires standard doping techniques and may be *motivated* by specific design considerations on the desired current-voltage characteristics, determined as the latter are by the depth of the energy levels.

(b) It has been held that mere selection of known materials generally understood to be suitable to make a device, such as any atom satisfying the criterion by Gerstenmaier that at least one energy level be at least 200 meV away from the valence band and conduction band, which criterion is satisfied for sulfur, the selection of the particular material being on the basis of suitability for the intended use, would be entirely obvious. In re Leshin 125 USPQ 416.

### ***Response to Arguments***

Applicant's arguments filed 5/12/06 have been fully considered but they are not persuasive.

In particular, to address arguments of traverse based on the newly added limitation, such as enumerated as argument 4 on page 7 of Remarks: in the combined invention by F. Bauer et al and Gerstenmaier et al the newly added limitation "resulting in said stop zone being only partially electrically active in the on-state and fully electrically active in the off-state" (which constitutes functional language; what matters only is whether the final structure as claimed is *capable* of having a stop zone that is only partially active in the on-state and fully active in the off-state, which is met because the conditions for the final structure are met; see rejection) is automatically met because the stop zone is in front of the emitter and is doped with foreign atoms with at least one energy level within the band gap of the semiconductor at least 200 meV away from both the conduction band and valence band of the semiconductor.

Applicants' argument (on pages 5-6) in traverse that Gerstenmaier does not teach a stop zone (page 6 of Remarks) does not appear to address the grounds for rejection of claim 5, in which F. Bauer et al was cited for teaching a stop zone. However, the zones 11 in Gerstenmaier are zones that form connections between the p-emitter and the n-base, as does the stop zone in F. Bauer et al (see Gerstenmaier, col. 2, l. 30-33).

Applicants' allegation (on page 6) that Gerstenmaier teaches placing the foreign atoms in the base, if taken to mean the basis as a whole, is not true: element 11 is a (electrical) connection between the emitter and the base while in applicants' own specification stop zone n forms a similar electrical connection between emitter 5 and base 1 (Gerstenmaier, col. 2, l. 30-33 and [0020]-[0021] of the specification). Thus, by a



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similar criterion applicant could be said to teaching placing foreign atoms in base 1, but actually a special zone is reserved therefor.

Applicants' further allegation (on page 7) that Gerstenmaier et al do not teach to place the foreign atoms in a conductivity different from that of the emitter is incorrect: element 11, the recipient of said foreign atoms in Gerstenmaier, has n-type conductivity (see col. 2, l. 49-53) while the emitter has p-type conductivity (col. 1, l. 55-57).

Applicants' further appear to allege that no argument for combination appears to exist, while the office action clearly provided one (see pages 3-4 of the office action mailed 2/13/06) not addressed in said Remarks. A further allegation of teaching away (page 8) of F. Bauer et al and Gerstenmaier et al is (a) unsubstantiated and (b) irrelevant even if true: "teaching away" only would be relevant if one reference teaches away from another, both being used in the same rejection. In response to applicant's argument that the purpose by Gerstenmaier et al for introducing foreign atoms with the claimed energy levels is different from the purpose of applicants (pages 7-8), the fact that applicant has recognized another advantage which would flow naturally from following the suggestion of the prior art cannot be the basis for patentability when the differences would otherwise be obvious. See *Ex parte Obiaya*, 227 USPQ 58, 60 (Bd. Pat. App. & Inter. 1985).

For the above reasons the rejections must be maintained.

***Conclusion***

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire **THREE MONTHS** from the mailing date of this action. In the event a first reply is filed within **TWO MONTHS** of the mailing date of this final action and the advisory action is not mailed until after the end of the **THREE-MONTH** shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than **SIX MONTHS** from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Johannes P. Mondt whose telephone number is 571-272-1919. The examiner can normally be reached on 8:00 - 18:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Jack W. Keith can be reached on 571-272-6878. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

JPM

July 19, 2006

Patent Examiner:

A handwritten signature in black ink, appearing to read 'J. Mondt', is written over the printed name.

Johannes Mondt (Art Unit: 3663)